OPERATING INSTRUCTIONS

FOR THE

TYPE 250-A RX METER

MP MASTER
MA24349

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

OPERATING INSTRUCTIONS
FOR THE
RX METER TYPE 250-A

These are temporary operating instructions sufficient for operation of the instrument; a final complete instruction manual will be issued in the near future and forwarded to you. Please return the attached self-addressed card to insure that the permanent manual reaches you.

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Preliminary Operating Instructions

for the

Type 250-A RX Meter

General

The Boonton Radio Corporation Type 250-A RX Meter is a completely self-contained instrument for measuring the equivalent parallel resistance and equivalent parallel reactance of two terminal networks in the frequency range of 0.5 to 250 mcs.

Specifications

Frequency Range: 0.5 to 250 mc continuously variable in eight self-contained ranges.

Frequency Accuracy: ±1%.

Resistance Range (R_p): 15 to 100,000 ohms. Values from 0 to 15 ohms can be determined by indirect means.

Accuracy of Resistance Measurements:

$$\pm \left(2 + \frac{Fmc}{200} + \frac{R_p}{5000} + \frac{Q}{20}\right) \%\ \pm 0.2 \text{ ohms}$$

where F_{mc} = frequency in megacycles; R_p = Equivalent parallel resistance as indicated by the RX Meter dial. $Q = \frac{R_p}{X_p}$ as determined from RX Meter indications.

Capacitance Range (C_p): 0 to 20 mmfd. By use of auxiliary resonating coils this range may be extended to 0 to 120 mmfd.

Accuracy of Capacitance Measurements:

$\pm(0.5 + 0.0002\ F^2mc)\%\ \pm 0.15$ mmf where F_{mc} = Frequency in megacycles.

Inductance Range (L): Values of L which will resonate with capacities from 0 to 100 mmf over the frequency range may be determined. By the use of auxiliary series resistors, values of L may be measured over the following ranges:

	L	
Frequency	Minimum	Maximum
0.5 mc	0.01 μh	100 mh
250 mc	0.001 μh	0.4 μh

Voltage Applied Across Unknown Impedance:

DC voltage = 0: External DC to 50 ma may be used.

RF voltage = Approximately 0.1 to 0.5 volts.

Power Requirements: 105 - 125 volts 50 - 60 cps 60 watts. (power supply of instrument internally regulated)

Tubes: The instrument is supplied complete with the following tubes:

2 Type 5718	1 Type 0D3
1 Type 6AB4	1 Type 5Y3
2 Type 6AG5	1 Type 6H-6 Ballast Tube

Dimensions: Height 10", length 20"; depth 12"

Weight: 40 pounds.

Description

This instrument consists essentially of an r.f. oscillator, which supplies a signal to a modified Schering bridge. The unbalance voltage from the bridge is introduced into a detector and heterodyned with the signal from a second

oscillator, operating at a frequency difference of 100 KC. This 100 KC voltage is then amplified by a high gain amplifier, rectified, and applied to the null indicating meter. Automatic gain control is incorporated into the amplifier to protect the meter during periods of maximum bridge unbalance and to provide maximum meter sensitivity at the point of balance.

Operating Instructions

1. Preliminary Adjustments:

1.1 Allow set to warm up about ten minutes before using at frequencies above 100 mc.

1.2 Set to desired operating frequency by means of "OSC RANGE" and "OSC FREQ" controls.

1.3 Set C_p dial to "0" and R_p dial to "∞". Be sure that red pointer on R_p dial indicates proper setting.

1.4 Place operator's fingers across binding posts (to unbalance bridge) and adjust "DETECTOR TUNING" knob until a maximum deflection of approximately 35 divisions is obtained on the "NULL INDICATOR" meter. A peak of less than this amount is usually an indication of an unusable harmonic frequency response instead of the desired fundamental. At high frequencies there are always two fundamental frequency responses that fall within the "DETECTOR TUNING" range; either of these peaks represents an equally satisfactory tuning of the detector. Harmonic

responses may be observed as sharper and considerably lower level peaks that always fall between the two fundamental peaks and may be accompanied by inability to balance the bridge or erroneous results.

1.5 Remove fingers from binding posts, tighten binding post nuts and adjust "ZERO BALANCE" controls (R and C) until the "NULL INDICATOR" shows a minimum deflection. This minimum deflection will vary between 0.5 to 3 divisions depending on frequency. The "ZERO BALANCE" controls are located just above and between the C_p and R_p dials. The fine "R" knob at the left is a vernier adjustment for the coarse "R" knob at the right; a single "C" knob is located in the center directly under the "R" knobs.

2. Measurement Procedure:

2.1 Connect apparatus to be tested to binding posts. Note that ground post "LO" is towards rear of cabinet. Keep lead length to a minimum.

2.2 If test component is known to be primarily resistive adjust R_p dial first until minimum deflection of meter is reached. Now adjust C_p and R_p dials alternately until a final minimum deflection on the "NULL INDICATOR" is obtained.

2.3 If test component is known to be primarily reactive, adjust C_p dial first for minimum deflection, then

adjust R_p and C_p dials alternately until a final minimum deflection on the "NULL INDICATOR" is obtained.

2.4 Record final dial readings C_p and R_p. If the C_p dial reads in the white (-) portion of the drum scale (above zero) it represents the negative capacitance or resonating capacitance for an inductive test component. If the C_p dial reads in the yellow (+) portion of the drum dial (below zero) it represents the capacitance of a capacitative test component. Be sure to note the location of red pointer on R_p dial which indicates active portion of dial.

2.5 The R_p dial reading represents the equivalent parallel resistance of the test component as seen by the bridge at the base of the binding posts.

3. Sources of Error:

The two inherent sources of error in the instrument are as follows:

3.1 Inductance of Internal Condenser.

This error can in most cases be neglected. Correction can be made by using Chart I for C_p dial readings in the white (-) portion of the C_p dial. Corrections are unnecessary for C_p dial readings in the yellow (+) portion of the C_p dial.

3.2 Binding Post Inductance.

All measurements are made effectively at the base of the binding posts. In those cases where the series inductance of the binding posts (0.003 microhenries) becomes an appreciable part of the reactance of the test component correction can be made as described in paragraph 4. below.

4. Corrections:

4.1 Capacitance Measurements (Yellow (+) portion of C_p dial)

A. Correction for Inductance of internal condenser. Negligible.

B. Correction for Binding Post Inductance.

$$\text{Corrected Capacity} = C_1 = \frac{C_p}{1 + \omega^2 L C_p}$$

where $\omega = 2\pi f$ (f in cycles per second)

$L = 0.003 \times 10^{-6}$ (henries)

C_p = dial reading $\times 10^{-12}$ (farads)

4.2 Inductance Measurements (White (-) portion of C_p Dial)

A. Corrections for inductance of internal condenser. Correction can be made for C_p dial reading using Chart I.

C_p true = C_p dial reading + ΔC

B. Correction for Binding Post Inductance.

This correction is made by subtracting algebraically from the calculated X_p value $\left(X_p = \frac{1}{\omega C_p \text{ dial reading}}\right)$ the inductive REACTANCE of the binding posts which

can be read from Chart II.

4.3 General

A. The above corrections are shown as a matter of information and for application where needed; a little experience in using the RX Meter will develop a sense of their relative importance.

5. Interpretation of Results:

5.1 In order to obtain other information concerning the test component such as Q or equivalent series values it is first necessary to determine X_p, the equivalent parallel reactance of C_p. This is readily done either by means of a precision reactance chart or by simple computation:

$$X_p = \frac{1}{\omega C_p} \qquad \text{Eq. (1)}$$

and from this the equivalent parallel inductance:

$L_p = \frac{X_p}{\omega}$ (for white (-) portion of C_p dial)

5.2 The Q value is now readily computed as follows:

$Q = \frac{R_p}{X_p}$ Where R_p is obtained from RX Meter dial reading and X_p from 5.1 above Eq. (2)

5.3 The equivalent series resistance is computed as follows:

$$R_s = \frac{R_p}{1+Q^2} \qquad \text{Eq. (3)}$$

$R_s = \frac{X_p^2}{R_p}$ When $Q>10$

$R_s = R_p$ When $Q < 0.1$

5.4 The equivalent series reactance is computed as follows:

$$X_s = \frac{X_p Q^2}{1+Q^2} \qquad \text{Eq. (4)}$$

$X_s = X_p$ When $Q > 10$

$X_s = \frac{R_p^2}{X_p}$ When $Q < 0.1$

5.5 The absolute impedance becomes:

$$Z = \frac{R_p}{\sqrt{1+Q^2}} \qquad \text{Eq. (5)}$$

5.6 The series inductance becomes:

$$L_s = \frac{C_p R_p^2}{1+Q^2} \qquad \text{Eq. (6)}$$

$L_s = \frac{1}{\omega^2 C_p}$ When $Q > 10$

$L_s = C_p R_p^2$ When $Q < 0.10$

5.7 The series capacitance becomes:

$$C_s = C_p \left(1 + \frac{1}{Q^2} \right) \qquad \text{Eq. (7)}$$

$C_s = C_p$ When $Q > 10$

$C_s = \frac{1}{R_p^2 \omega^2 C_p}$ When $Q < 0.1$

6. Special Procedure for Low Inductance Measurements:

6.1 When it is desired to measure an inductance value at a frequency that would require more than 100 μμf resonating capacitance, it may be done by connecting a resistor in series with the coil, thus reducing the Q and the required C_p capacitance in accordance with Equation (6).

6.2 The recommended value of series resistor depends on the inductance to be measured and is indicated below:

Inductance Range	Resistor
10 µh - 1000 µh	1000 ohms
1 µh - 10 µh	316 ohms
0.1 µh - 1 µh	100 ohms
0.001 µh - .1 µh	31.6 ohms

The attached reactance Chart 3 indicates the formula to be used and the series resistor required for inductance values in the above ranges.

6.3 It might be worth noting that Equation (6) is the general form which can be used with any of the above resistors. In any case, when making low inductance measurements using the special procedure described above it is the value of R_p, as read on the RX Meter, that is used in the equations. Since this R_p includes the series resistor, the value and accuracy of the series resistor is not significant and need only be approximate.

7. Measurements of Self-Resonance of Coils:

7.1 The self-resonant frequency of a coil can be found by determining the frequency at which the RX Meter will indicate balance at C_p = "0" with the test coil connected.

8. Operating Precautions:

8.1 If balance cannot be obtained, recheck detector tuning as described under Section 1.4.

8.2 Keep test component lead lengths to an absolute minimum and minimize stray capacitance from test component to top of instrument (ground).

Cable Measurements on 250-A RX Meter

I. Characteristic Impedance

1. Cut 1/4 wavelength and short circuit end. If length is correct, $C_p = 0$. If not, trim cable or adjust frequency.

2. Take a resistor near Z_o (100 ohms is satisfactory) and measure resistor on terminals of RX Meter Call this R_1

3. Measure same resistor through 1/4 W.L. Cable. Call this R_2

4. $Z_o = \sqrt{R_1 R_2}$

II. Attenuation Factor

1. Cut 1/2 wavelength cable and leave open-circuited. If length is correct, $C_p = 0$. If not, trim cable or adjust frequency.

2. Read R_p. Then,

   db. atten./length of cable used = $\frac{Z_o}{R_p} \times 8.69$

   Note: If 1/2 W.L. of cable is less than four feet, use a one or 3/2 W.L. piece with no change in procedure (i.e. C_p will still = 0) to minimize effect of irregularities in cable, etc.

III. Velocity of Propagation Factor

$$V = \frac{\text{Physical length of 1/2 W.L. cable}}{\text{Physical 1/2 wavelength in air}}$$

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NLR-10-2-53

EXAMPLE:
f = 200 Mc Cp DIAL = -65 μμf
REDG
Cp TRUE = 65 - 6 = -71 μμf

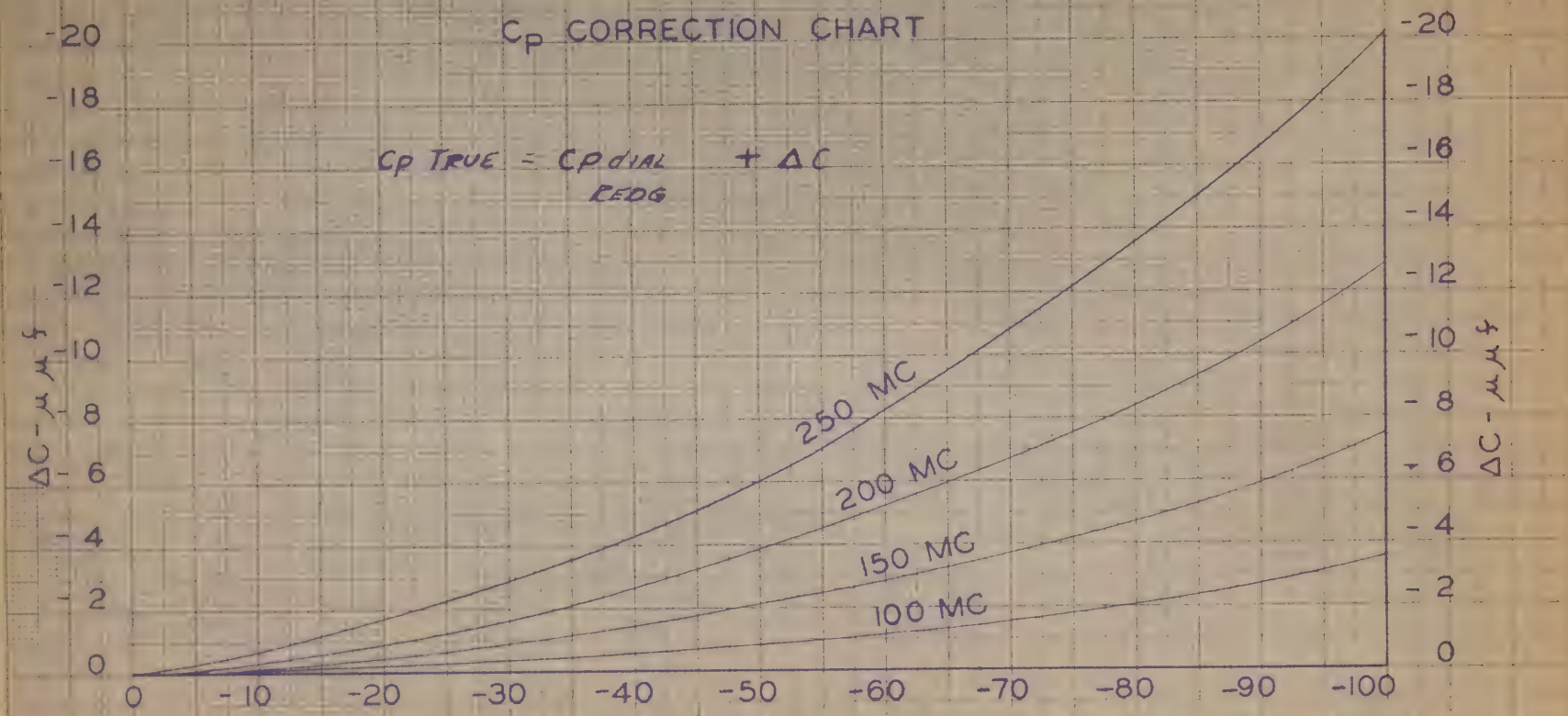
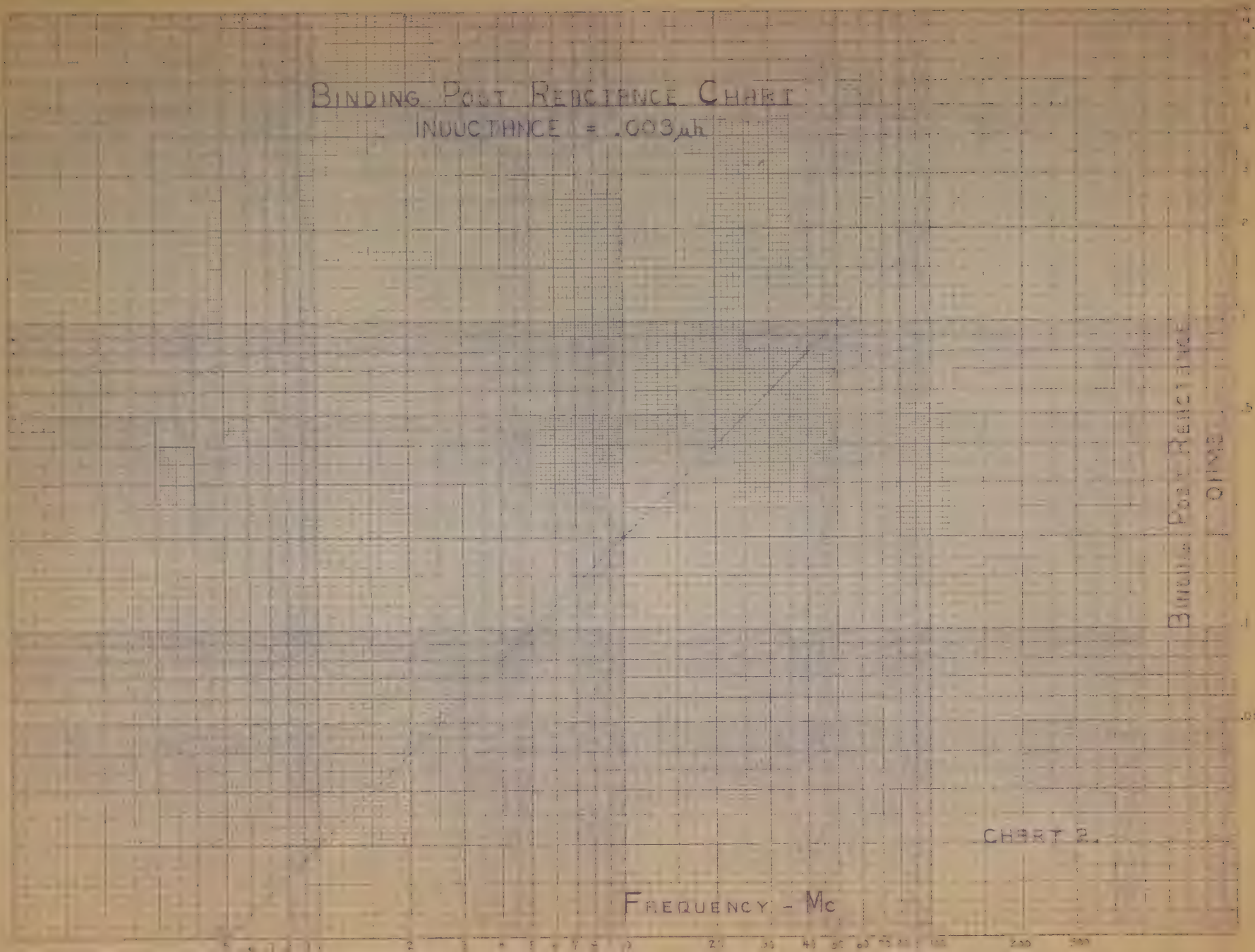


CHART I.

BINDING POST REACTANCE CHART

INDUCTANCE = .003 μh



INDUCTANCE RANGES
250-A RX METER

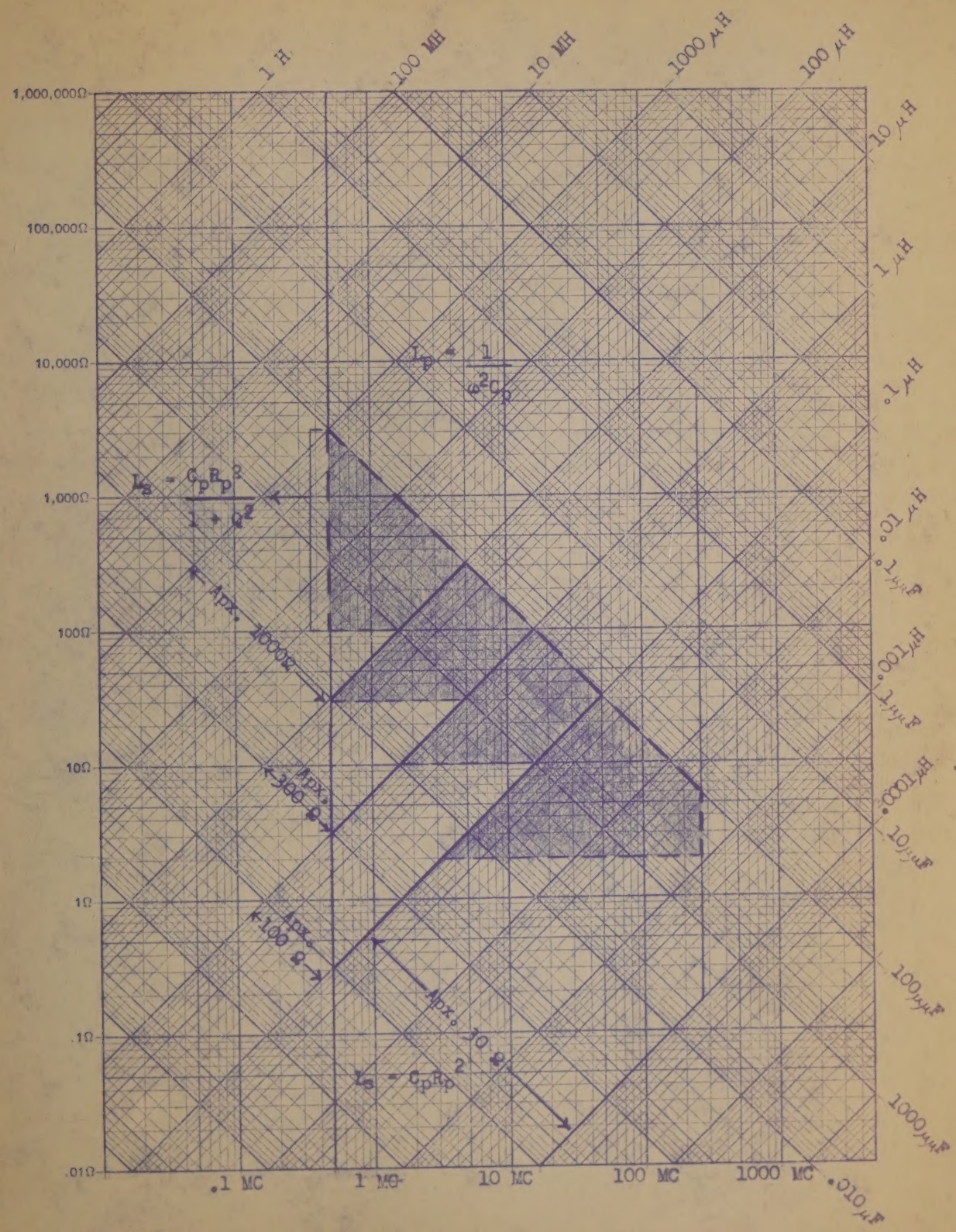


CHART 3

Standard Graph Sheet, Bell Laboratories.

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MA24349